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Development of Chemistry Module Based on Science Literacy at MAN 4 Aceh Besar

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Abstract: The learning process carried out so far at MAN 4 Aceh Besar only uses printed books. Based on interviews obtained from chemistry teachers, it was stated that the printed books available at the school have not been able to improve students' understanding of the material on elemental chemistry. This study aims to produce a valid, practical and effective elemental chemistry learning module. This study uses the R&D (Research and Development) product development research method with the 4D model. The subjects of this study were students of class XII MIA 1 MAN 4 Aceh Besar. The results of the study obtained the validity of the module with a very valid category, the results of the student practicality test were obtained from the practicality questionnaire with a fairly practical category, the results of the effectiveness test were obtained from the results of the student's completeness posttest with a very effective category. Based on the results obtained from the validity, practicality and effectiveness tests, it was concluded that the elemental chemistry module based on scientific literacy at MAN 4 Aceh Besar was included in the valid, practical and effective categories used in the teaching and learning process for elemental chemistry material.

Keywords: Chemistry module, science literacy, science education.

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INTRODUCTION

Education is a process that has developed in the modern era today, which creates fierce competition in life. A teacher must have the ability to master technological developments and be able to overcome challenges in the learning process. The learning process occurs when a teacher acts as a facilitator who directs the learning process systematically. As a facilitator, the teacher functions as an aid for students in maximizing learning. In addition, media can also be used as a tool for students due to the limited time and place faced by teachers (Yuliati, 2017)

In learning, media is a means to create an independent learning atmosphere. Teachers really need media as a tool to convey learning messages. One form of media used is a module, which plays a major role in chemistry learning (Sukiminiandari, 2015). Concepts such as composition, changes in properties, structure, and energy are factors

that are influenced by chemical energy. Chemistry also studies natural phenomena on Earth and has been studied through concepts and theories developed by scientists (Redhana, 2019).

The chemistry of elements, especially in grade XII, is a profound material. Its relation to life is very diverse. However, the concepts and theories presented in the chemistry of elements tend to be abstract. This often makes it difficult for students to understand the material because the concepts are still limited and abstract. The many abstract theories in chemistry of elements result in students being less able to solve problems (Habibati, 2019).

Science is a science that develops through the process of research, problem formulation, temporary hypotheses, hypothesis testing through experiments, conclusions, and discovery of concepts and theories. One of the education systems that measures scientific literacy skills is the PISA (Program for International Student Assessment) Program which is international (Delfita, 2018). In the PISA ranking, Indonesia is in a low position. For reading ability, Indonesia is ranked 72 out of 77 countries (Nyamik, 2022).

The PISA program compares educational achievements in various countries. One of the main factors causing low scientific literacy of students is the lack of a scientific literacy approach in the learning process using existing materials. Scientific literacy is the ability to understand scientific concepts and apply them in everyday life. According to PISA, scientific literacy involves understanding scientific concepts and their application in situations related to human activities (Sutrisna, 2021).

Science literacy has very important benefits for students, because they not only understand the concept of science, but are also able to apply it in everyday life. The development of good science literacy in students has several interests, including providing satisfaction after studying science, creating solutions to public problems, and being useful in the world of work that requires logical thinking, creativity in concluding decisions, and the ability to solve problems (Sutrisna, 2021).

Research involving observations of the school environment and interviews with chemistry teachers at MAN 4 Aceh Besar revealed several problems, including limited material in books and students' lack of understanding in understanding the concept of elemental chemistry in an abstract way, which is reflected in student test scores that do not reach the Minimum Completion Criteria (KKM). Therefore, a science literacy-based elemental chemistry module was developed as an effort to overcome these problems (Khofifah, 2021). The study entitled "Development of a Science Literacy-Based Elemental Chemistry Module at MAN 4 Aceh Besar" aims to evaluate the validity, practicality, and effectiveness of the science literacy-based elemental chemistry module at MAN 4 Aceh Besar.

METHODS

The method used in developing this product is the Research and Development (R&D) method. The approach used in this development is to use the 4D model, namely Define, Design, Development, and Disseminate. Define, Needs analysis is carried out to identify the needs of students and teachers in learning elemental chemistry. These needs are used as the basis for determining the objectives and scope of module development. Design, At this stage, the media and format that will be used in making the elemental chemistry module are determined. The module design is adjusted to the needs of students and considers the visual aspects, structure, and completeness of the material. Development, This stage involves making an elemental chemistry module based on the established design. The module is developed by considering aspects of validity, suitability to the curriculum, and ease of use and understanding for students. Disseminate, The developed module is socialized to students and chemistry subject teachers.

Socialization is carried out through product introduction, module usage training, and module distribution to teachers as a means of learning elemental chemistry. With the

4D model approach, the development of elemental chemistry modules can be carried out systematically and in a directed manner, with a focus on meeting the needs of students and teachers, as well as ensuring the quality and usefulness of the developed modules.

This study involved a population of class XII students in the 2022-2023 academic year. The sample used in this study consisted of 21 students who were members of class XII MIA I. The sampling process was carried out using the purposive sampling method. In this study, three types of instruments were used to collect data. The instruments are Validation sheet used to assess the validity of the module used in the study. This sheet contains questions or statements related to the validity criteria of the module, such as clarity of material, relevance to the curriculum, and suitability to learning objectives.

Respondents will provide responses or assessments for each item on the validation sheet. Practicality sheet used to assess the practicality of the module. This sheet contains questions or statements related to ease of use, relevance to student needs, and relevance to classroom teaching. Respondents will provide responses or assessments for each item on the practicality sheet. Test instrument questions used to test the effectiveness of the module. This instrument consists of 12 questions designed to measure understanding and application of the material taught through the module. These questions will be given to students to answer as part of the module effectiveness assessment.

The three instruments were used in this study to collect data relevant to the research objectives and to evaluate the validity, practicality, and effectiveness of the module used. Data collection techniques used in this study through validation, questionnaires and test instrument sheets. Data analysis techniques used in analyzing data that has been collected from validity, practicality and effectiveness tests using qualitative and quantitative descriptive analysis techniques with percentage calculation methods. Qualitative descriptive analysis is to describe the discussion of quantitative results, while quantitative calculates the results of percentage data in the form of validity, practicality and effectiveness tests.

RESULTS

The Define stage is the initial stage in module development, where researchers analyze the characteristics of students, materials, and tasks related to the product to be developed. In this stage, researchers analyze the learning objectives of elemental chemistry material and its specifications.

The Design stage is the second stage in product development. At this stage, product design is carried out by selecting the media and format to be used. The selection of media is based on the analysis of core competencies, basic competencies, and achievement indicators used in chemistry teaching by teachers. The Canva and Microsoft Word applications are used in designing the module cover. Materials for the elemental chemistry module were collected from SMA/MAN chemistry textbooks, internet sources, journals, and university books. The elemental chemistry module developed aims to be a learning medium for knowledge and skills competencies in KD 3 and 4. This stage begins by installing the Canva application to design an attractive cover design. The initial design involves selecting material indicators, searching for illustrations according to the chemical element material, and designing module sections such as covers, tables of contents, forewords, KI, KD, GPA, glossary, and entering material content, images, non-routine exercises, practicums, evaluations, and bibliographies until the chemical element module is ready to be developed.

The Development stage is the stage where the developed product is tested for validity by three validators, consisting of two lecturers and one chemistry teacher at MAN 4 Aceh Besar. The purpose of the chemical element module validation test is to determine the validity of the product that has been developed.

The final stage of this research is the Dissemination stage. The purpose of this stage is to introduce the module to users so that it can be used properly in schools and classes

after being validated. After the chemical element module is confirmed to be very valid, the next stage is to implement and disseminate the science literacy-based module at MAN 4 Aceh Besar. The dissemination of this module aims to evaluate its practicality and effectiveness for students through the use of questionnaires and test instruments.

Validity

Table 1. Validity data results from 3 validators

Indicator	Evaluation	Validators		
		V_1	V2	V3
(I) Graphic aspects	Suitability of size to the content of the module	4	4	4
	Appearance of layout elements on the front cover	4	3	4
Module size	Color of layout elements	4	3	3
	The font used is attractive and easy to read	4	4	4
	The font size of the module title is more dominant and proportional compared to the size of the module and the author's name	4	4	4
	The color of the module title contrasts with the background color	4	4	4
	Use of a combination of letters	4	3	4
	Illustration of the module cover	3	3	4
	Use of content/teaching materials that reveal the character of the object	4	3	4
	The shape, color, and size of the module are in accordance with reality	4	3	4
Module content design	Harmonious layout elements	4	3	4
	Proportional print areas and margins	4	4	3
	Appropriate spacing between text and illustrations	4	4	4
	Complete layout elements	4	3	4
	Learning activity title, learning activity subtitle and page numbers	4	3	4
	Illustrations and captions	4	3	4
	Page layout	4	4	4
	Placement of decorations/illustrations as backgrounds does not interfere with text and pages	4	3	4
	Placement of titles, subtitles, illustrations and captions does not interfere with understanding	4	3	4
	Simple module content typography	4	3	4
	Use of fonts	4	3	4
	Use of letter variations (bold, italic, all capital, small capital) is not excessive	4	4	4
	Normal text layout width	4	4	4
	Use of spacing between lines of text layout	4	4	3
	Use of spacing between letters	4	4	3
(II) media aspect	Cover illustration depicts the contents of the module	4	4	4
	The color display on the cover is attractive	4	4	4
module cover	The color display on the module is attractive	4	4	4
Form letters in modules	The shape of the module letters is easy to read	4	4	4

	Suitability between the background and the writing	4	4	4
	The shape of the letters in the module is easy to read	4	4	4
	Suitability of font selection in the module	4	4	4
	Presentation of images in the module	4	4	4
	Not using too many fonts			
(III) content aspect	Completeness of material reviewed from KD	4	3	4
	Depth of material reviewed from KD	4	3	4
Suitability of material to KD	Suitability of font selection in the module	4	3	4
Accuracy of chemical element material	Conceptual accuracy	4	4	4
	Image and illustration accuracy	4	4	4
	Term accuracy	4	4	4
	Question accuracy	4	3	4
(IV) Science literacy aspect	Examples of material can be found in everyday life	4	4	4
Elements of science literacy	Examples of material are easy to observe in the environment	4	4	4
(V) language aspect	Sentence structure accuracy	4	4	4
	Sentence effectiveness	4	4	4
	Term standardization	4	4	3
straightforward Communicative and interactive	Ease of presenting material for students	4	4	4
Suitability of rules to language	Grammatical accuracy Conceptual accuracy	4	4	4
Total		**195**	**178**	**191**
Average		**3.9**	**3.6**	**3.8**
Precentage		**99.48%**	**90.81%**	**96.93%**
Criteria		**Very valid**	**Very valid**	**Very valid**

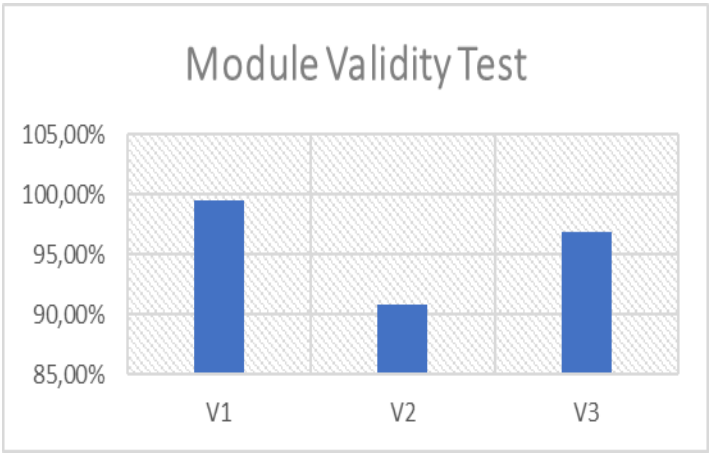

Figure I. Total percentage validity score graph

Based on the data obtained from the three validators to test the validity of the module, Figure 1 shows that the percentage results of the module feasibility test by validator 1 are 99.48%, validator 2 is 90.81%, and validator 3 is 96.93%. The three validators provide a percentage of results reaching 95% with the criteria of "very valid". Thus, it can be concluded that the module presented is very valid and ready to be distributed.

Practicality

The practicality of the elemental chemistry module based on scientific literacy was carried out by providing a questionnaire to class XII MIA I students. The purpose of the questionnaire was to determine the practicality of the elemental chemistry module based on scientific literacy at MAN 4 Aceh Besar.

Table 2. Practical results of the module

No	Rated aspect	Student assessment			
		(4)	(3)	(2)	(1)
1.	Language used in the module	8	13		
2.	Instructions presented in the module	6	15		
3.	Sentences in the module	7	14		
4.	Problems presented in the module	2	17	2	
5.	Examples of material related to nature	8	13		
6.	Illustrations of images/diagrams in the module	11	9	1	
7.	Intent/purpose of each question/problem in the module	6	13	2	
8.	Display of writing contained in the module	9	10	2	
9.	Display of illustrations or images contained in the module	11	8	2	
10.	Presence of illustrations or images in the module to understand chemical concepts	2	16	3	
11.	Delivery of material in the module to understand chemical concepts	9	10	2	
12	Explanation of practice questions linking scientific literacy	5	13	3	
13	Delivery of test questions	3	17	1	
14	Illustrations can be found around	9	8	4	
15	Diagrams according to material linking scientific literacy	9	11	1	
Number of frequencies		105	187	23	
Number of scores		420	561	46	
Maximum score		1260			
Percentage score (%)		33.33	44.52	3.65	
Maximum percentage score		81.51 %			
Criteria		quite practical			

Based on table 2, the student questionnaire on the practicality of the scientific literacy-based chemical element module that has been developed, a percentage of 81.51% was obtained with the criteria of being quite practical. The total practicality score of students was 1027 with a maximum practicality questionnaire score of 1260. The percentage of the total practicality questionnaire score of the module can be seen in the graph below:

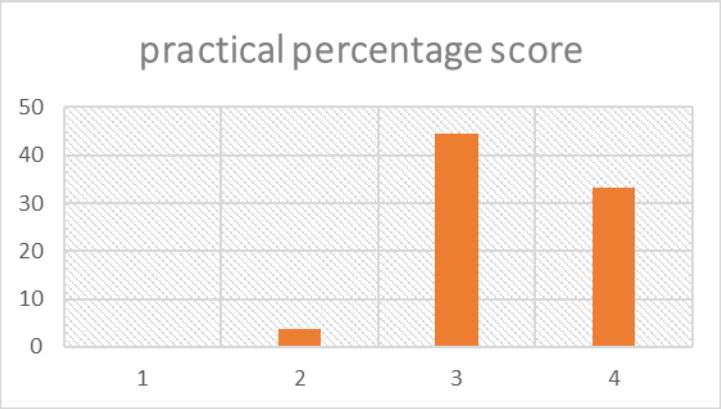

FIGURE 2. Total percentage graph of module practicality score

Based on the picture above, it shows that the highest percentage of the practicality questionnaire of the module distributed to students is at number 3, then followed by number 4 and the least number 2 and number 1 were not chosen. So that the practicality of the elemental chemistry module based on scientific literacy is stated to be quite practical with a percentage of 81.51%.

Effectiveness

Students who have a completeness of >85 are 18 students and students who have not completed the score below <85 are 3 people who have not met the KKM of 85. These results show that the effectiveness test tested in the class can be concluded that the results of the effectiveness test reached 85.71% completeness in the 2013 curriculum so that the elemental chemistry module based on scientific literacy is declared effective to be applied in chemistry subjects, especially in elemental chemistry material.

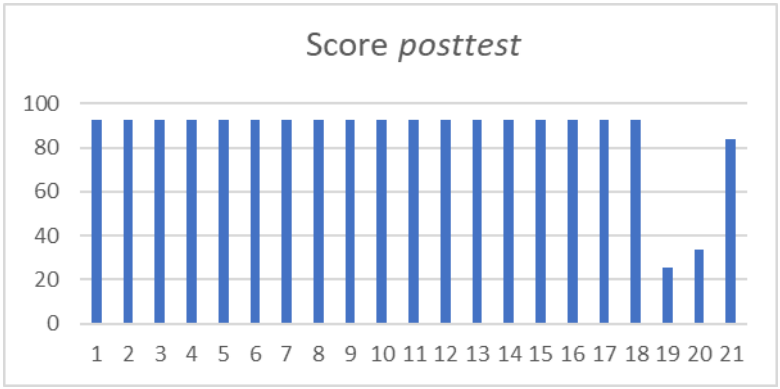

FIGURE 2. Student completion graph through Posttest

Based on Figure 3, the effectiveness of using the module through the posttest obtained a value of 90 with a percentage of 85.71% with a very effective criterion. So that this elemental chemistry module based on scientific literacy is effective for use in chemistry subjects at MAN 4 Aceh Besar.

DISCUSSION

The results of this study indicate that the development of a chemistry module based on scientific literacy can improve students' conceptual understanding and critical thinking skills. The developed module has gone through validation stages by material experts and media experts, and has been tested on students to see its effectiveness in learning. From

the validation results, this module obtained a very valid category with an average score above 85%, indicating that the content, presentation, language, and media feasibility have met good criteria.

Based on limited trials conducted on a group of students, there was a significant increase in their learning outcomes after using this module. The results of the pretest and posttest showed that the average student score increased by 30%. This indicates that the science literacy-based module is able to help students understand chemical concepts better than conventional learning methods. In addition, student responses to this module were very positive. Most students felt that this module was more interesting than ordinary textbooks because it was equipped with illustrations that supported understanding of the material. Students also stated that this module helped them in connecting chemical concepts with real phenomena in everyday life, in accordance with the main objective of scientific literacy.

In terms of structure, this module is designed using a scientific literacy approach that involves four main aspects: real context, scientific concepts, scientific competence, and reflection on social impacts. The presentation of material that begins with contextual phenomena makes it easier for students to understand the relevance of chemical concepts in everyday life. For example, in learning electrolyte and non-electrolyte solutions, this module presents examples of coconut water and isotonic drinks as applications of concepts in real life. In addition, this module also emphasizes the aspect of critical thinking skills through exploratory questions and analysis tasks. The results of the data analysis showed that after using this module, students were better able to ask in-depth questions, analyze experimental data, and make logical conclusions. This shows that the scientific literacy-based module not only improves conceptual understanding but also scientific thinking skills. In terms of readability, this module has been tested using the Cloze Test method to measure students' level of understanding of the text presented. The results show that most students can understand the contents of the module well, with a readability percentage reaching 80%. This shows that the language used in the module is quite simple and in accordance with the level of understanding of high school students.

Observation results during the trial also showed that this module can increase student involvement in the learning process. Students become more active in discussing, asking questions, and relating chemical concepts to everyday life. This is different from previous learning methods that tend to be more passive and teacher-centered. In addition, the analysis of the effectiveness of the module based on questionnaires and interviews showed that students were more motivated to learn chemistry using this module. Several students stated that they previously considered chemistry as a difficult and abstract subject, but with this module, they found it easier to understand the material because it was associated with examples that were close to their lives.

The results of this study also found that the use of scientific literacy-based modules provided additional benefits for teachers in managing learning. Teachers felt more helped in delivering the material because the module had provided a systematic and interactive learning scenario. Thus, the teacher's role is more focused on facilitating learning rather than simply providing information. Although this module shows high effectiveness, there are still some obstacles that need to be considered. Some students who have low reading skills have difficulty understanding some of the more complex parts of the text. Therefore, in the future, it is necessary to develop a more adaptive module with varying levels of difficulty to adjust to the characteristics of diverse students. In addition, this study also shows that this module is more effective when integrated with discussion-based or experimental learning methods.

Students who only read the module without further exploration tend to have lower understanding compared to those who actively discuss and conduct simple experiments suggested in the module. In terms of application, the results of this study can be the basis for the development of similar modules for other subjects. The concept of scientific literacy applied in this module can be adapted in physics, biology, and mathematics

learning to improve students' critical thinking and problem-solving skills. The development of this scientific literacy-based chemistry module has been proven effective in improving student learning outcomes, critical thinking skills, and learning motivation.

Therefore, it is hoped that this module can be implemented more widely in chemistry learning in various schools to improve the quality of science education in Indonesia. The development of this module can be further enhanced by including interactive digital features such as augmented reality or virtual laboratory simulations. Thus, chemistry learning is not only text-based but also more interactive and in accordance with technological developments.

CONCLUSION

Based on the research on the development of the elemental chemistry module based on scientific literacy at MAN 4 Aceh Besar, it can be concluded that the module obtained positive results. The following are the conclusions that can be drawn Module Validity, The elemental chemistry module based on scientific literacy has gone through a validity test by three validators. The results show that this module is very valid, with a validity percentage value of 95%. Validator 1 gave a validity percentage of 99.48%, validator 2 90.81%, and validator 3 96.98%. Module Practicality, This module has also been tested to evaluate its level of practicality. The evaluation results show that this module is declared practical, with a practicality value of 81.51%. Module Effectiveness, The module effectiveness test was conducted to assess the extent to which this module is effective in achieving learning objectives. The results of the effectiveness test showed that this module was very effective, with an effectiveness value of 85.71%. Based on these findings, it can be concluded that the science literacy-based elemental chemistry module developed in this study has a high level of validity, good practicality, and significant effectiveness. This module can be used as a valid, practical, and effective learning resource in learning elemental chemistry at MAN 4 Aceh Besar.

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